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On an unfair suppression of due acknowledgment to the writings of Mr. Benjamin Gompertz. By PROFESSOR DE MORGAN.

IN 1839, in the *Penny Cyclopaedia* (article "Mortality"), I wrote as follows, referring to Mr. Gompertz's well-known hypothesis on the law of mortality :—

" We enter into some detail of it the more readily, that it is necessary as an act of justice to Mr. Gompertz, whose ideas have been adopted by a recent writer on the subject, without anything approaching to a sufficient acknowledgment."

Mr. Gompertz gave his theory in the *Philosophical Transactions* for 1825, p. 513, in a paper *On the Nature of the Function expressive of the Law of Human Mortality.*

The writer of whom I assert that he gave a suppressive account of what Mr. Gompertz had done is Mr. T. R. Edmonds, in a work entitled *Life Tables founded upon the Discovery of a Numerical Law, &c.*; London, 1832; 8vo.

My attention has been again drawn to this matter by two things—first, the account given of Mr. Edmonds's alleged discovery by his proposer, in the list of candidates for admission into the Royal Society; secondly, the following mention of Mr. Edmonds by Dr. Farr, in a paper *On the Construction of Life Tables* (*Phil. Trans.*, 1859, part ii., p. 844) :—

" I shall now notice briefly the application of this hypothesis, first suggested by Mr. Gompertz, and applied by him to the interpolation of the Northampton and other tables. Mr. Edmonds, in 1832, extended the ' Theory,' and applied it to the construction of three Life-Tables. He gave an elegant formula, similar in principle to that of Mr. Gompertz, from which the curve of a Life-Table can be deduced, upon the above hypothesis."

The first of these circumstances occasioned my pointing out to a fellow of the Royal Society what I had written in 1839, with explanation. Some correspondence followed between him and a friend of Mr. Edmonds, I having first stated my view of the case in writing. On May 31st, I was shown a letter from Mr. Edmonds's friend, recommending* a reference; and also a letter from Mr. Edmonds himself, in reply to my statement just mentioned. As the reasoning in the first paragraph of this letter showed me clearly that publicity must be the result, I declined to read any further, and expressed my intention of taking the course which I now do take.

I shall not trouble the reader with any account of what I think

* This recommendation I adopt: my referees are all who are competent to judge and who choose to read.

about the character or motive of the suppression, nor of my own motive in bringing it forward. I will put the case before him, desiring him to consider it no case at all unless, true quotation being assumed, he find it one to which he cannot imagine a sufficient answer. I will add that I have had no communication whatever with Mr. Gompertz on the subject, direct or indirect, past or present.

The account which Mr. Edmonds gave of Mr. Gompertz's theory is as follows (pp. xvii., xviii.) :—

"The honour of first discovering that some connexion existed between Tables of Mortality and the algebraic expression (a^x) belongs to Mr. Gompertz: but to arrive at this single common point, his course of investigation differs so widely from mine, that appearances will be found corresponding to the reality,—that my discovery is independent of the imperfect one of Mr. Gompertz."

It is here asserted :—

1. That Mr. Gompertz discovered that *some connexion* existed, and that this—namely, that *some connexion* existed—is the *single common point*. It shall be shown that *all* the points of Mr. Edmonds's alleged discovery had been published by Mr. Gompertz; the only difference being that Mr. Edmonds takes in the period of infancy, to which Mr. Gompertz pays no attention.

2. That the two courses of investigation differ widely. If the *published* courses of investigation be intended—and no others can present "appearances" to the reader—it shall be shown that they closely agree.

3. That the discovery of Mr. Gompertz is imperfect—meaning, of course, as compared with that claimed by Mr. Edmonds. It shall be shown that there is no difference between the two, except in the introduction of the period of infancy by Mr. Edmonds, according to the method of Mr. Gompertz.

I now give the quotations which substantiate these points :—

Mr. Gompertz (p. 8).

"ART. 5.—If the average exhaustions of a man's power to avoid death were such that at the end of equal infinitely small intervals of time, he lost equal portions of his remaining power to oppose destruction which he had at the commencement of those intervals, then at the age x his power to avoid death, or [used in the sense of

Mr. Edmonds (pp. xvi., xvii.).

"The force of mortality is a simple function of the age, or time from birth, and is always of the form (ap^x) during each of the three periods of Infancy, Manhood, and Old Age. . . . Let, now, (y) represent the number Living or Surviving at any time (x). The force of mortality at that time= ap^x =decrement in unit of time on unit of life; the

and also] the intensity of his mortality might be denoted by aq^x , a and q being constant quantities; and if L_x be the number of living at the age x , we shall have $aL_x \times q^x \dot{x}$ for the fluxion of the number of

deaths $= -(L_x) \dot{x}$; $\therefore abq^x = -\frac{L_x}{L_x} \dot{x}$,
 $\therefore abq^x = -\text{hyp. log.}^*$ of b [misprint for q] \times hyp. log. of L_x , and
putting the common logarithm of $\frac{1}{b}$
[here b should be q again] \times square of the hyperbolic logarithm of $10 = c$, we have $c \cdot q^x = \text{common logarithm}$
of $\frac{L_x}{d}$; d being a constant quantity, and therefore L_x , or the number of persons living at the age of $x = dg^{q^x}$; g being put for the number whose common logarithm is c ."

Thus it appears that having a single point in common—namely, that a^x has some connexion with tables of mortality—arrived at by widely different courses of investigation, means as follows:—

Mr. Gompertz assumes that the intensity of mortality is aq^x .

Mr. Gompertz arrives at the fluxional equation

$$-\dot{L}_x = aL_x \times q^x \dot{x}.$$

Mr. Gompertz integrates this into

$$L_x = dg^{q^x}.$$

The difference is the difference between intensity and force; between a and a ; between q and p ; between L_x and y ; between fluxions and differentials; between d and $10^{\lambda p}$; between g and $10^{-\frac{k^2 a}{\lambda p}}$; and between a formula which gives dg when $x=0$, and another which gives 1.

In applying his formula, Mr. Gompertz finds it necessary to change the constants at a period depending upon the table to be verified. Thus, taking life from 10 years of age, and not consider-

finite decrement of (y) at that time $= y \times ap^x$; and the true decrement, or the decrement in an infinitely small given time, $= yap^x dx$; that is, $-dy = yap^x dx$. Using (l) to signify hyperbolic logarithm, and (e) to denote the base of that system, we obtain by

integration, $\int \frac{dy}{y} = \frac{a}{\lambda p} p^x$ and $\frac{y}{y} = e^{\frac{a}{\lambda p} p^x}$.

If it be assumed that $y=1$ when $x=0$, then $g=e^{\frac{a}{\lambda p}}$, and the equation becomes $y = e^{\frac{a}{\lambda p}} \times e^{-\frac{a}{\lambda p} p^x}$, or $y = e^{\frac{a}{\lambda p}(1-p^x)}$.

And calling the modulus of the common system (k), and using (λ) to signify common logarithm, the equation will finally become—

$$y = 10^{\frac{k^2 a}{\lambda p}(1-p^x)}.$$

Mr. Edmonds assumes that the force of mortality is ap^x .

Mr. Edmonds arrives at the differential equation

$$-dy = yap^x dx.$$

Mr. Edmonds integrates this into

$$y = 10^{\frac{k^2 a}{\lambda p}(1-p^x)}.$$

* The preceding b is a superfluous constant, which is useless. It seems to have originated in the idea that the diminution of the number living is proportional to the intensity of mortality, and therefore represented by that intensity multiplied by a constant. But the constant a , already introduced, is sufficient.

ing infancy, he finds one set of constants to represent the Carlisle Table from 10 to 60, another from 60 to 100. Mr. Edmonds finds the same necessity, but he also takes in the period of infancy, and applies the law to the periods from birth to 8 years of age, from 12 to 55, and from 55 to the end of life, acknowledging that the periods vary with circumstances.

Mr. Gompertz considers, as appears by one of his examples, that the constant q is very slowly varying during the period at which it is near enough to uniformity for practical use. Mr. Edmonds seems to assume that during each whole period of its use, his constant q is absolutely fixed; but of this he does not give any evidence. For the logarithms of q , by the Carlisle Table, from 10 to 60, and from 60 to 100, Mr. Gompertz has 0·0126 and 0·0271. In Mr. Edmonds's book, the logarithms of p , from 12 to 55, and from 55 to the end of life, are 0·0128 and 0·0333. Mr. Edmonds calls his constants "now first discovered" (p. vi.).

I can find nothing in which Mr. Edmonds went beyond Mr. Gompertz. It is now for him to show that he not only went beyond Mr. Gompertz, but so far beyond that all which was due to Mr. Gompertz was comprised in the statement that the whole of what I have quoted gives the *single common point* that a^{bx} has *some connexion* with tables of mortality. Should he wander from this point—which is *the* point—it will be my part to request insertion of a short exposure of irrelevancy. I will conclude by observing that I do not care to inquire whether or no what Mr. Edmonds published, as above quoted, was done independently of Mr. Gompertz, as asserted. On this point it will be well to suspend opinion until it is seen what Mr. Edmonds can say in justification of the suppressive mention which, I submit, has been fully established.

On some Considerations suggested by the Annual Reports of the Registrar-General, being an Inquiry into the Question as to how far the Inordinate Mortality in this Country, exhibited by those Reports, is controllable by Human Agency. (Part II.) By H. W. PORTER, Esq., B.A., Assistant Actuary to the Alliance Assurance Company, Fellow of the Institute of Actuaries and of the Statistical Society.

[Read before the Institute the 27th February, 1860.]

WITH respect to the inhalation of woolly matter, Mr. Leigh, a surgeon at Manchester, and Registrar of Deaths for the Deans-